The Second International WEAR Conference The Banff Centre, Banff, Alberta, Canada July 31 – August 1, 2007

Program

Tuesday, July 31, 2007

08.30 **Welcome** M.Rioux, NRC, Ottawa, Canada

08.45 **Keynote "Dimensions of Anthropometry: Convention or Expansion"**
Shrawan Kumar, University of Alberta, Canada

09.30 **Introduction of the WEAR members**

10.10 – 10.30 ***Coffee break***

10.30 **WEAR Overview,**
Kathleen M. Robinette, U.S. Air Force Research Laboratory, USA

10.55 **Live demos, WEAR Tools**
R. Mollard, Université Paris Descartes, France. M. Mochimaru, Digital Human Research Center, Japan. M. Rioux, NRC, Canada

11.30 **3D Anthropometric Data collection**,
Hein Daanen, Frans Nennie, TNO Defence, Security and Safety. Marc Rioux**,** NRC.

11.55- 13.30 ***Lunch***

13.30 **Database system**
R. Mollard, Université Paris Descartes, France

13.55 **Use of CAESAR data to Develop Multivariate Cases and Digital Human Models for the Automotive Industry**
Greg Zehner and Kathleen Robinette, Air Force Research Laboratory, USA

14.20 **Quality Control of Anthropometric Database**
Makiko Kouchi and Masaaki Mochimaru, Digital Human Research Center, National Institute of Advanced Industrial Science and Technology, Japan

14.45 **Consistent Parametrization and Principal Component Analysis of 3D Anthropometry Data**
Chang Shu, Pengcheng Xi and Zouhour Benazouz, Institute for Information Technology at the NRC, Canada

15.10- 15.30 ***Coffee break***

15.30 **Geological tour**, Jim Oliver, Director of Customer Services, The Banff Centre

17.30 **Return to the Banff Centre**

18.00 **Dinner**

Wednesday, August 1, 2007

08.45 **Invited Speaker " Putting the Right Fit before the Right Stuff"**
Pierre Meunier, Defence R&D, Toronto, Canada

09.30 **Body shape browser based on homologous body modeling**
Masaaki Mochimaru and Makiko Kouchi, Digital Human Research Center, National Institute of Advanced Industrial Science and Technology, Japan

10.10 – 10.30 ***Coffee break***

10.30 **Size China**
Johan Molenbroek, Delft University of Technology, Netherlands
Roger Ball, Polytechnic University, Hong Kong

10.55 **Life-Like Apparel Mannequins from 3-D Human Data**
Daisy Veitch, Managing Director, Sharp Dummies Pty Ltd, Australia
Kathleen Robinette, US Air Force Research Laboratory, USA

11.30 **3D Shape Representation and Analysis of the Human Body Head and Ontology for Anthropometric Landmarks**
Afzal Godil, National Institute of Standards and Technology (NIST), USA

11.55- 13.30 ***Lunch***

13.30 **Principles of Fit to Optimize Helmet Sizing**
Catherine Harrison and Kathleen M. Robinette, U.S. Air Force Research Laboratory, USA

13.55 **Constrained Virtual Tailoring from Anthropometric Data, 3-D Shape and Data Mining**
Eric Paquet, Institute for Information Technology at the National Research Council Canada
Herna L. Viktor, Hongyu Guo, Isis Pena Sanchez, School of IT and Engineering, University of Ottawa, Canada

14.20 **Determining foot shape and size for boot last design**
Lorraine Mac Duff, K. Bredenkamp and H. Nolte, ERGOnomics TECHnologies, Pretoria, South Africa

14.45 **Comparing Samples from Different Countries for Key Sizing Dimensions**
Youngsuk LEE, Chonnam National University, Seoul, Korea
Kathleen M. Robinette, U.S. Air Force Research Laboratory, USA
Daisy Veitch, Managing Director, Sharp Dummies Pty Ltd, Australia

15.10- 15.30 ***Coffee break***

15.30 **Development of the AFRL CAESAR Web User Interface**
Huaining Cheng and Kathleen M. Robinette, US Air Force Research Laboratory, USA
Steve E. Mosher and Mark S. Boehmer, General Dynamics Advanced Information Systems, USA

15.55 **Open Space Workshop**
All presenters will be available for detailed question and answers and demonstrations of databases and their applications. Each presenter will be in the open space so that participants can meet with any presenter during this time.

17.00 **Summary and close**

Shrawan Kumar

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Dr Shrawan Kumar is currently a Professor in Physical Therapy in the Faculty of Rehabilitation Medicine and in the Division of Neuroscience, Faculty of Medicine at the University of Alberta. He is an Honourary Fellow of the Association of Canadian Ergonomists, and Fellow of the International Ergonomics Association, Human Factors and Ergonomics Society of USA, and the Ergonomics Society of UK. Dr. Kumar was awarded the Sir FredéricBartlett Medal for excellence in ergonomics research by the Ergonomics Society of U.K. in 1997. In the year 2000 he was awarded Jack Kraft Innovator Award by the Human Factors and Ergonomics Society, USA andErgonomics Development Award by the International Ergonomics Association for conceptualizing and developing the sub-discipline ofRehabilitation Ergonomics. He has been an invited keynote/plenary speaker at about 40 national and international conferences in North and south Americas, Europe, Asia, Africa and Australia.

Dr. Kumar has over 430 scientific peer-reviewed publications and works in the area of musculoskeletal injurycausation/prevention with special emphasis on low-back pain. He has edited/authored elevenbooks/monographs. He was an Editor of the International Journal of Industrial Ergonomics until 2003 and Assistant Editor of Transactions of Rehabilitation Engineering, and continues to be Consulting Editor ofErgonomics, Associate Editor of Spine, and Associate Editor of The Spine Journal. He serves on the Editorial Boards of five other international journals and as a reviewer for several other international peer-reviewedjournals.

He has served as Chair of the 'Code of Ethics' sub-committee of the International Ergonomics Association. Currently he serves as the International Ergonomics Association Liaison Officer for the Association ofCanadian Ergonomists.

Shrawan Kumar (Keynote)

University of Alberta, Canada

Dimensions of Anthropometry: Convention or Expansion

Abstract

Human performance and work output requires physical effort on part of the worker. Physical effort is largely affected by human form and functional capacity in quantitative terms. Therefore, generally but not always, the work is designed such that it is more or less compatible with at least human form. But do we give the same consideration to the function?

Anthropometry (measure of man) has largely considered the measures of human form to design work and work places. In spite of this, mismatches are not all that uncommon. However, when one considers the diversity of human faculties involved in occupational activities the nature and range of mismatches become diverse and complex. This presentation will explore the required human faculties for work performance and desirability of their incorporation in measuring man (Anthropometry). A conceptual framework will be presented for matching work and worker.

Kathleen M. Robinette

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Dr Kathleen Robinette is a pioneer and technology leader in human anthropometrics, whose research and developments have positively impacted the quality of life and work of countless people around the world. Her research has literally changed the way anthropometric data is utilized in equipment design, particularly with respect to the development of technical standards. Dr Robinette is responsible for the development of the world's first three-dimensional (3D) anthropometry scanner in 1985, (a head scanner), and the world's first 3D whole body scanner in 1993. As the director of the Air Force's Computerized Anthropometric Research and Design (CARD) Laboratory, she developed a new initiative to collect 3D anthropometric data that will ultimately result in a better fit between people and their tools, systems, and environments. She planned, negotiated, and directed the first successful 3D whole body human measurement survey; CAESAR, Civilian American and European Surface Anthropometry Resource.

In addition, she developed the fit-mapping method which is used to effectively size products during product development. This method was first implemented for the Navy Women's uniform, improving the percentage accommodated without alterations to 99% without increasing the number of sizes! Prior to this only 25% of Navy women were able to get a fit without costly alterations. Kathleen is a Fellow of the Human Factors and Ergonomics Society and has received many honors and awards over the years including: Outstanding Scientist Award from the Affiliate Societies Council, the Arch T. Colwell Award from the Society of Automotive Engineers, the Women in Government Award from Good Housekeeping Magazine, and the Outstanding Alumnus Award from Wright State University.

Kathleen M. Robinette

U.S. Air Force Research Laboratory, USA

WEAR Overview

Abstract

Anthropometric data, the measure of human body size and shape, are collected and used by all types of organizations for many types of applications. These include universities, hospitals, health statistics departments, militaries, apparel companies, furniture manufacturers, automobile manufacturers, safety equipment companies, aerospace companies, and many more. Collecting such data can be expensive yet sharing of data is generally done sparingly, informally, and haphazardly. This presentation outlines a plan to develop a resource for sharing anthropometric data effectively in order to make needed information readily available, quickly, and accurately, while at the same time minimizing cost. It describes the proposed resource development technical plans, the anticipated costs, the main products, explains the current status, and some potential future efforts that could be explored. It also details the proposed partnership relationships and the anticipated investments by the different partners.

Greg Zehner and Kathleen Robinette

Air Force Research Laboratory, USA

Use of CAESAR data to Develop Multivariate Cases and Digital Human Models for the Automotive Industry

Abstract

To avoid the problems associated with the sole use of summary statistics to describe human variability, several examples of the use of multivariate cases will be presented. While cockpit and automotive interior design appear to be similar applications, the anthropometric variables of interest and morphology of the user populations can differ dramatically. User descriptions culled from the CAESAR datasets can be problematic when variables of interest are highly correlated with body weight. The CAESAR data are non normal for these variables. A method to correct for this issue will be presented. Further, digital human modeling of obese populations results in unrealistic body shapes for the models. An example from the SAFEWORK model will be discussed.

Catherine Harrison and Kathleen M. Robinette

U.S. Air Force Research Laboratory, USA

Principles of Fit to Optimize Helmet Sizing

Abstract

The present research sought to apply underlying principles that determine helmet fit to develop a scientific design method for determining the minimum number of helmet sizes to accommodate the full anthropometric variability of the population. The method was tested on a prototype helmet concept using a stratified sample of males and females drawn to represent the Joint Strike Fighter population. Asian- and African- American subjects were specifically included in order to examine the effects of racial anthropometric variability on fit. While the range of accommodation for the initial design was broad, it encompassed only a portion of subjects who fell within the 99% probability ellipse for the target population, while accommodating a broad range of subjects falling outside the 99% probability ellipse, best meeting the fitting needs of a very small subset of the population. Applying a fit mapping method determined that two helmet two sizes, sized and

shaped differently than those initially proposed and with a modified fitting concept, would accommodate 99% of both males and females. The fit mapping process also provided specific, quantified feedback to the designers on size and shape modifications needed to make the helmet to provide better fit for the full range of the population. Determining the parameters that link anthropometric principles to fit of a specific piece of equipment permit design modifications to equipment to be made early in the design process using only a single size prototype, resulting in fewer sizes while ensuring accommodation of the desired population.

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Professor Hein Daanen holds the chair in Thermal Physiology, Vrije Universiteit, Amsterdam and is Head of the Department of Human Performance, Business Unit Human Factors, TNO Defence, Security and Safety. He has had an illustrious career in physiology, ergonomics and anthropometry. His achievements include:

Project manager of anthropometric surveys for the Royal Netherlands Air force and Navy, and how to use these data for cockpit design and evaluation

Project manager of protective mask and helmet fit testing

Author of a biomechanical computer model to calculate the load on human joints

Author of several books and over 50 refereed journal articles (see http://home.wanadoo.nl/daanen)

Hein Daanen, Frans Nennie

TNO Defence, Security and Safety

Marc Rioux

Institute for Information Technology at the National Research Council Canada

Whole Body Scanners

Abstract

The first whole body scanners emerged in 1995. In 1999 a review of whole body scanning techniques and systems was presented (Daanen, H.A.M., Van de Water, G.J. Whole body scanners. Displays 19: 111-120). Now, eight years later, we will present an update of available systems including software and new trends. Laser scanning systems are still the most accurate on the market, but expensive. For the apparel industry some laser systems are developed with less accuracy and lower costs. TC2 is the leading company in patterned light projection scanners due to acceptable price setting. However, scanning accuracy is not as good as in laser scanning. A relatively new method is based on millimeter waves. These scanners can scan through clothing layers, but resolution is poor. Raw scans consist of point clouds. The clouds of each camera have to be aligned first and then merged into one single file. Some post processing is necessary to fill holes due to occlusion effects. Finally, if the processing is done accurately, and the scan is an exact copy of the body, software may be applied to derive additional body dimensions from the scan. The apparel industry is unfortunately still focused on 1D dimension like chest circumference because 3D techniques are still under development. The 1D dimensions generated by the available software (Human Solutions, TC2) are reproducible, but generally do not correspond very well to 1D measures determined by skilled anthropometrists. The question is if the link should be established or if the results should be treated separately. Progress is made in the link between 3D body scans and garment design with software packages like Vidya, Optitex and Narcis.

Régis Mollard

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Régis Mollard is Professor in Ergonomics – Head of the Human Factors and Ergonomics Laboratory "Ergonomics - Behaviour and Interactions (EA4070)" and of the Laboratory of Applied Anthropology (sub-part of EA4070) at Paris 5 University. He holds a PhD in 3-D Surface Anthropometry and Human Modelling. His research areas are databases in ergonomics, 3-D morphological studies, posture and comfort in transport and military activities, fatigue, workload and stress in transport operations. Régis was the Scientific Advisor for the French civilian 3-D Anthropometry survey for the apparel industry (2003-2006) and is responsible for the new French military anthropometry survey (2007). He has conducted consultancies in the application of ergonomics and anthropometrics for FELIN project (infantryman with integrated equipment and links) the French Military programme for the Army and in the analysis of accidents in aeronautics for the French Board for Accident Investigation. He is a Member of the European Committee for Aircrew Scheduling and Safety (ECASS), a Member of the French Society of Biomechanics, and a Member of Psychophysiology in Ergonomics (PIE), a technical committee of the International Ergonomics Association (IEA).

Régis Mollard

Paris Descartes University

The use of an on-line anthropometric database system for morphotype analysis and sizing system adaptation for different world market apparel sportwear

Abstract

WEAR is a collaborative effort to create a world wide resource of anthropometric data for a wide variety of engineering applications. The user of anthropometric data can access the available data through a central portal. It is foreseen that the databases of WEAR will be used by people from different countries. So, it is necessary to define the structure of a series of databases linked together, with a direct access through the web. The sub systems are numerous:

- Organized data files of 1-D and 3-D raw data linked with data query tools and statistical modules,
- Shape analysis methods,
- Biomechanical data files,
- Bibliographical data files and synthesis files in ergonomics,
- Methods and/or tools for fit tests,
- Examples of results for design purposes,
- Tools for on-line help and assistance.

Two examples of analysis of anthropometric data from such database systems will be presented. The first one concerns the use of a database system (ERGODATA in this case study) to identify the differences of morphology according to the needs expressed in projects from manufacturers or apparel industry. Based on demographic criteria, surveys or specific samples can be extracted from the database system. Then Principal Component Analysis and hierarchical classification tools are used to:

- select the main measurements that explain the variance between subjects,
- compute and determine the main principal axis,
- classify groups of subjects according to their location regarding to these principal axis in a multidimensional referential,
- analyse the differences in terms of criteria of size and shape and characterize the main morphotypes for each survey or sample.

The second example is the analysis of morphological variability for key measurements used in sizing systems by the apparel industry. A case study is presented for different sportswear suits. The issue was to identify the adjustment of a French sizing system for foreign populations (USA and China). In this case study, the first step was to confirm the fit of the existing sizing system for the updated data for the French population then to estimate the percentage of fit for the two other populations (USA and China). After a log transformation to normalize the distribution for measurements related to weight, a bivariate distribution tool is used to check the fit coverage in the anthropometric space for each size. According to percentage of coverage, new sizes are added to optimize the fit and existing sizes are eliminated where no or only a few number of subjects are included.

Makiko Kouchi

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Dr Makiko Kouchi (D.Sci) is a senior researcher at the Digital Human Research Center, National Institute of Advanced Industrial Science and Technology, Japan. She studied physical anthropology and received master's degree and doctor's degree from the University Tokyo. Her research interests include variations in human body due to growth, secular change, and movement, as well as modeling and analysis of 3D human body shape. She received awards including Promotion prize of Anthropological Science for a Significant Paper (1992), AIST Director-General's Award (2000), and Basic Research Award in International Society of Biomechanics, 5th Footwear Symposium (2001). She is also related to 1D and 3D anthropometric researches in Japan including the quantification of measurement errors and validation protocol of 3D scanners. She is an active member of Anthropological Society of Nippon, and a member of ISO/TC159/SC3/WG1.

Makiko Kouchi and Masaaki Mochimaru

Digital Human Research Center, National Institute of Advanced Industrial Science and Technology, Japan

Quality Control of Anthropometric Database

Abstract

In order to provide reliable anthropometric data, WEAR group intends to evaluate the quality of each database from the document of the anthropometric research related to the database. We intend an objective evaluation using a checklist sheet, and there will be also a subjective evaluation from the database provider. The quality of data depends on the (1) validity of the subject population, and (2) comparability and (3) reliability of anthropometric data. In order to assure the comparability of data (measurements with the same name were measured using the same methods), we will examine the definition of each measurement from different databases, and use a common XML schema to express the measurement items. The checklist will contain items related to the following: (1) enough background information to judge if the subject population is in accord with the user's target population (year and place of examination, progress of the secular change, etc.), (2) indicator of skill of measurers such as technical error of measurement and training, (3) data editing, (4) accuracy of instrument/measurement system evaluated using an object with known dimensions, (5) repeatability of scan-derived measurements using an object, an anthropomorphic dummy, and humans (1D measurements, location of landmarks, and surface shapes), (6) for 1D measurements, comparison results with measurements taken by the traditional methods.

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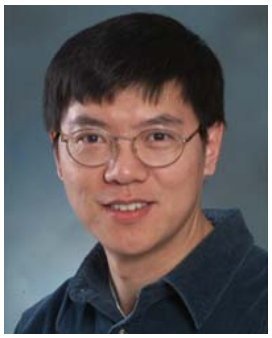

Dr. Chang Shu is a senior research scientist at the Institute for Information Technology, National Research Council of Canada. He is also an adjunct research professor at the School of Computer Science, Carleton University. He received Ph.D in computer science at the Queen Mary College, University of London, UK, in 1992, and B.Sc in computer science and mathematics at Harbin Institute of Technology, China, in 1985. From 1992 to 1996, he was a research associate in the Department of Mechanical and Aerospace Engineering at the Carleton University, Ottawa, Canada. From 1996 to 1998, he was a research scientist at the Integrated Manufacturing Technologies Institute of the NRC. Dr. Shu has served as a member of program committee, organizer, and paper reviewer of many conferences and workshops. He is also a grant reviewer for the Natural Sciences and Engineering Research Council Canada. He has developed techniques and algorithms for representing and processing shapes in two and three dimensional space. He has also transferred technologies to Canadian companies. In 2003, he received NRC Outstanding Achievement Award.

Chang Shu, Pengcheng Xi and Zouhour Benazouz

Institute for Information Technology at the National Research Council Canada

Consistent Parametrization and Principal Component Analysis of 3D Anthropometry Data

Abstract

Recent 3D anthropometry surveys, such as the CAESAR project, provide tremendous amount of information about the shape of the human body. In this paper, we present a system that analyzes the full-body surface models. In order to make use of these data, that is, to analyze and characterize the human body shape, the models have to be made to correspondence to each other. One way of doing this is to fit a generic surface model to each scanned model such that the key anatomical points are in correspondence. The fitting can be guided by the anthropometry landmarks. However, the placing of the landmarks prior to scan is a tedious and time-consuming task. Because of this, few existing anthropometry databases have landmarks and it is unlikely that future 3D anthropometry surveys will include them. In this paper, we present a method that automatically locates the landmark positions. The method is based on statistical learning. We use the landmark data in the CAESAR database as a training set. Local surface properties and distance between landmarks are used to learn the parameters of a probabilistic graphical model. The prediction of the landmark locations is formulated as finding the maximum likelihood configuration of the landmark labeling. Belief propagation is used to solve the optimization problem efficiently.

Once we have a reliable set of landmarks, we fit a generic mesh model to each individual data model. This is done by smoothly deforming the generic mesh to the data model through nonlinear optimization. We use radial basis functions on landmarks to speed up the deformation. This avoids the use of multi-resolution meshes and hand tuning of parameters. Finally, we perform principal component analysis (PCA) on the parameterized data set. The main mode of variation of the whole body shape is analyzed. Since each model is parameterized by a template mesh, different body parts, like the head, arms, legs, and torso can be analyzed separately. We present PCA results on each of these parts. Through these analyses, we show that the space of the human body shape can be spanned by a small number of basis vectors. We also demonstrate that some of the main mode of variations correspondence to intuitive human body variations such as height and weight.

Pierre Meunier

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Pierre Meunier is a defence scientist at the Toronto branch of the Defence R&D Canada agency. His main area of research focuses on engineering anthropometry as it pertains to the Canadian Forces (CF). He has developed expertise in 2D and 3D anthropometric data acquisition methods, the use of multivariate methods to solve individual and population accommodation problems for clothing, equipment and workspaces. His work has resulted in the fielding of the BoSS-21 (Body Scanning System), which is used across Canada for the sizing and distribution of clothing and equipment for the CF. He was responsible for the largest traditional and non-traditional anthropometric survey in CF history. One of his current research interests centres on anthropometric screening methods for the selection of personnel, based on *Bona Fide* Occupational Requirements. This work resulted in the adoption by the CF of new anthropometric selection standards for pilots. Mr Meunier received his B.Eng (mechanical) from McGill University, and his MSc degree in Industrial & Systems Engineering (Human Factors Engineering option) from Virginia Tech.

Pierre Meunier (Invited)

Defence R&D Canada

Putting the Right Fit before the Right Stuff

Abstract

The Canadian Forces (CF) recently introduced a new set of tools in its pilot selection process. Its purpose is to provide a scientific basis for the anthropometric assessment of aircrew to ensure that the safety and effective operation of any CF aircraft isn't compromised by body size and shape. It is based on empirical data collected on every CF aircraft, which were transformed into predictive models of accommodation through the use of multivariate statistics. Critical anthropometric variables are used in conjunction with aircraft characteristics to determine whether a pilot candidate will have a sufficient amount of "vision over the nose" for safe landings, the required amount of stick authority, enough leg clearance on ejection seat aircraft to clear the structure, as well as sufficient reach to actuate all necessary controls and switches.

Defence R&D Canada developed a method of digitally scanning the physical dimensions of potential aircrew candidates in standing and sitting postures and extracting the necessary measurements. A computer program, the Pilot Anthropometric Screening Software (PASS), then uses the anthropometric information to determine which aircraft fleets an aircrew candidate would be physically eligible to fly. Appropriate and timely decisions can then be made regarding the continuation of aircrew selection, training and career planning.

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Dr Masaaki Mochimaru holds a Ph.D. (Engineering) from Keio University and is the Deputy Director, Digital Human Research Center, National Institute of Advanced Industrial Science and Technology, Japan. His research interests are: measurement technologies of human body shape, deformation and motion; footwear biomechanics (shoe design based on foot factors); digital human modeling for product assessment; and the application of ergonomics to product design (clothes, eyeglasses, gloves, computer mouse etc). Dr Mochimaru has received many awards for his work. He is a member the IEEE Computer Society, SAE international, International Ergonomics Association and Japan Ergonomic Society, Japan Society of Biomechanism, The Society of Instruments and Control Engineers.

Masaaki Mochimaru and Makiko Kouchi

Digital Human Research Center, National Institute of Advanced Industrial Science and Technology, Japan

Body shape browser based on homologous body modeling

Abstract

Generation of 3-D body shapes statistically representing a population is a useful technology for product design. We developed a method to generate a homologous model based on scanned point cloud and anatomical landmarks. A template model of the whole body consisting of about 8,000 polygons is created. Around 40 landmarks are assigned the vertices of the template body model. The template model is automatically fit into the individual scanned point cloud by minimizing external and internal energy functions: (1) the external energy-1 is defined as the sum of Euclidean distances between landmark vertices of the template model and measured landmarks, (2) the external energy-2 is defined as the sum of Euclidean distances between vertices of the template model and the closest point of scanned data, and (3) the internal energy is defined as the elastic energy between the adjoining vertices and adjoining polygons. In order to solve the posture difference between the template model and the individual body scan, the template model has a skeletal structure and its posture is changed to minimize the external energy-1 before the morphological fitting. Using this method, whole body homologous models were generated for 100 male and female body scans. 3-D morphological features of these homologous models were obtained by a principal component analysis for males and females separately. 12 principal components were obtained for males and females. Since variations in 3-D body shape can be represented by these principal components, a body shape browsing software based on principal components was developed. Any possible body shape can be generated with changing principal component using a smart GUI. Body dimensions of generated shape are calculated and appear on the screen. The software “Body Shape Browser” can be utilized for mass product design.

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Johan Molenbroek is Associate Professor Applied Ergonomics at Delft University of Technology in the Netherlands and Visiting Professor at the University of Bath in the United Kingdom. He has 28 years experience in research and teaching students industrial design engineering. Johan is also the current President of the Dutch Ergonomic Society. Johan has worked on anthropometric surveys from children to the elderly <www.dined.nl>, and coordinated the Gerontechnology Educational Network in Europe and the Friendly Rest Room project. Currently he is the consultant on the Hong Kong project <www.sizechina.com> where data from 2000 Chinese 3D head scans are now being processed into design tools for the better fit of head wear. Johan has particular expertise in the use of anthropometry in the design of school furniture, products for the elderly and the handicapped - especially about toilets, and also in educational tools in engineering anthropometry.

More information on www.linkedin.com/in/molenbroek/

Johan Molenbroek

Delft University of Technology, Netherlands

Roger Ball

Polytechnic University, Hong Kong

Size China

Abstract

This project aims at the first-ever digital database of Chinese head and face shapes. Currently, consumer products such as sunglasses, motorcycles helmets and hygienic face masks are designed using data from Western sources which fails to properly consider good fit for Chinese users. Size China will meet the design need for accurate data by creating a practical, sophisticated design measurement database for use by industries developing the next generation of perfect fitting products. A laser scanner is used to collect the scans from six different regions in China, in collaboration with local mainland industries and universities. Data collected will be used to create physical and digital virtual models for application in medical, optical, entertainment and sports industries. Traditional anthropometric methods with tape and calipers are also used to be able to compare the data on both ways. Funding for the project is provided in part by the Hong Kong Government and by a range of leading Hong Kong industrial partners. To develop this research project an international team of was initiated in the field of anthropometrics, scanning technology, CAD data creation and rapid prototyping. This presentation will illustrate the purpose, the method and the preliminary results of this project.

Daisy Veitch

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Daisy Veitch, winner of Australian Wool Corporations Young Designer of the Year Award and the Queen Elizabeth II Silver Jubilee Award for Young Australians has experience in all stages of garment production — from design to the finished product. Daisy is the Managing Director of SHARP Dummies that conducted the recent size survey of 1200 women across Australia. Daisy is on all the Standard Australia working committees to define measurements used for clothing sizes and is a member of ASTM D-13 committee that defines apparel sizes in the US.

Daisy can talk about body scanning, anthropometry, rapid prototyping and mannequin production, clothes fit and sizing.

Daisy Veitch

Managing Director, Sharp Dummies Pty Ltd, Australia

Kathleen Robinette

US Air Force Research Laboratory, USA

Life-Like Apparel Mannequins from 3-D Human Data

Abstract

Mannequins are produced for use by the apparel industry to assess apparel fit and grading. The 3-D shape, posture and size of the mannequins are exact copies of 3-D scan data of an individual selected in the target market's 'sweet spot'. This presentation will describe the 'sweet spot' and how it is determined. 3-D mannequins of other sizes are available to test the allometric (3-D) grade. The mannequins are made from materials that give them life-like properties to provide the best assessment of fit. Mannequins feature bone 3-D landmark information to produce an underlying skeleton. 3-D landmarks suitable for use by the apparel industry must be palpated and pre-marked on the subject before scanning. Prototype mannequins are milled using approximately 300,000 3-D data points. These data maintain dimensional and postural accuracy and precision and are not artificially idealized thus produce fit mannequins that represent real people, are bio-fidelic (life-like) and who represent groups of apparel customers. A sample 3-D mannequin will be on display.

Afzal Godil

National Institute of Standards and Technology (NIST), USA

Afzal Godil is a project leader in the Information Technology Laboratory at National Institute of Standards and Technology (NIST) where he has been for over ten years. Prior to that he worked at the NASA Langley and Lewis Research Centers as a contractor. His main focus in research and development is in the area of 3D graphics/visualization, digital human modeling, computational methods, and pattern recognition. He was also a principle technical staff member in the initiation and development of 3D Face Recognition and 3D shape searching. Finally he is active in a variety of standards efforts, such as VRML/X3D, Medical extension of X3D, biometrics and the “Anthropometry--human body size/shape analysis" project. He has a MS in Aerospace and Mechanical Engineering from the University of Arizona.

Afzal Godil

National Institute of Standards and Technology (NIST), USA

3D Shape Representation and Analysis of the Human Body Head and Ontology for Anthropometric Landmarks

Abstract
The 3D scans of human bodies in the CAESAR human database contain over two hundred fifty thousand grid points. To be used effectively for analysis, indexing, searching, clustering and retrieval, these human bodies require a compact shape representation.

We have developed two such compact representations based on human head shape by applying Principal Component Analysis on the facial surface and in the second method the whole head is transformed to a spherical coordinate system and expanded in a basis of Spherical Harmonics.

We also have developed compact representations based on human body shape descriptor based on lengths mostly between joints of single large bones and in the second method silhouettes of the human body are created and then encoded as Fourier shape descriptors.

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Eric has a B. Sc. in Physics and an M. Sc. in Nonlinear Quantum Optics. He received his Ph.D. in Computer Vision and Optical Information Processing from Laval University (Quebec City, Canada) in 1994. After finishing his Ph.D., he worked on 3D Optical Information Processing at the University of Valencia (Spain), on Laser Super-Resolution Microscopy at the Technion-Israel Institute of Technology (Haifa) and on 3D hand held scanners (London, England).

Eric Paquet

Institute for Information Technology at the National Research Council Canada

Herna L. Viktor, Hongyu Guo, Isis Pena Sanchez

School of IT and Engineering, University of Ottawa, Canada

Constrained Virtual Tailoring from Anthropometric Data, 3-D Shape and Data Mining

Abstract

Clothes should be designed to tailor well, fit the body elegantly and hide obvious body flaws. To attain this goal, it is crucial to understand the interrelationships between different body measurements, such as the interplay between e.g. shoulder width, neck circumference and waist. This paper discusses a study to better understand the typical consumer, from a virtual tailor's perspective. Cluster analysis was used to group both the male and female populations into five clothing sizes, ranging from small to extra-extra large. Next, a number of classification techniques were applied to analyze the interplay between each group's anthropometric measurements. In addition, demographic profiling of the cluster members was performed in order to better understand the typical consumer. Throughout this study, three-dimensional body scans were used to verify the validity of our findings. Our results indicate that different body measurements are used to characterize each clothing size. This information, together with the demographic profiles of the typical consumer, provides us with new insight into our evolving population.

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Lorraine heads up the Research and Training within ERGOnomics TECHnologies, a parastatal ergonomics institute for the South African military services. She has a MSc Human Movement Science from North West University, on determining the manual handling capability of a specific population, a BSc (hons)(med) Ergonomics from University of Cape Town and a Diploma of Occupational Therapy from Mohawk College/McMaster University, Canada. She acted as project leader for annual anthropometric surveys for several years and was the principal author of the South African military standards pertaining to 1D anthropometry and functional body strength. She has recently been on research teams to address fit and ease tolerance of clothing with regard to body shapes, design inputs for female body armour and is currently working on characterising foot shapes for the South African National Defence Force using 3D foot scanner technology.

Lorraine Mac Duff, K. Bredenkamp and H. Nolte

ERGOnomics TECHnologies, Pretoria, South Africa

Determining foot shape and size for boot last design

Abstract

This paper will discuss the application of 3D anthropometry and the integration of other sources of data in addressing the challenge of boot design. Characterization of the foot for application of boot design and last development must address three critical aspects: Form, fit and function. Historically, only one dimensional anthropometric data was available on the feet of the South African military population that could be used for the purpose of fit, but little or no data on form or function, (that is movement and pressure patterns) were available.

Making use of the traditional anthropometric database, analysis determined that there were clear indications of certain ethnic populations having characteristics such as narrow feet. This characteristic was not being suitably accommodated in the narrow boot range. Supplementary studies made use of pressure arrays to determine the position of hot spots and the typical footprints. The results identified the problem areas of mismatch between the user population foot profile and the boot shape and size, as well as the shock absorbency deficiencies inherent in the boot. These findings have led to two current projects which will be outlined briefly. Firstly, the building of a detailed biomechanical foot model in which anthropometric data was input and the properties of the boot sole was populated to firstly determine and then predict shock attenuation values. Secondly, a 3D foot scanner was acquired and a pilot study undertaken to characterize foot forms using principle component analysis. A full 3D foot survey is to be undertaken during this year.

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Professor Young-Suk LEE (Lys) is Professor at the Chonnam National University, Department of Clothing and Science, Korea, has had over 20 years of research experience. She has been an executive member of the Ergonomics Society of Korea since 1985. Lys gained a PhD in clothing ergonomics OTSUMA University, Japan and has been engaged in research in labor-physiology at Marburg University, Germany. She is the International Standards Organization (ISO) Liaison representative for Korea. Lys has published over 100 articles and many books and reports in the field of anthropometric research and standardization. Since 1997 Lys has been engaged in many anthropometric projects and surveys for the Korean government. These include general anthropometric surveys, such as a survey of women's body proportions, as well as surveys for application in a variety of industries including clothing, shoes, school furniture, headwear, products for the elderly, military uniforms, eyeglasses, and the development of manikins for the apparel industry.

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Kathleen M. Robinette

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Daisy Veitch

Managing Director, Sharp Dummies Pty Ltd

Comparing Samples from Different Countries for Key Sizing Dimensions

Abstract

The globalization of world markets with the increase of imports-exports between an ever greater number of countries means that concurrence will benefit those who can satisfy demand, in their own national market as well as abroad, with the best accuracy. Quite a few countries have gathered data on the human body characteristics of their populations and in particular developed sizing systems based on key sizing dimensions. These are of great utility not only for the national garment manufacturers but also for all makers whose objective is to propose ready-made clothes for outside markets. But if most industries are interested in anthropometric data, their need is however not only focused on raw data. Transforming these data in a comprehensive and suitable manner to facilitate their integration in the design process is usually also needed Computers nowadays are a big help in the task of prototyping, facilitating the procedure of creation. Thus digital models can be run on the basis of 3D or 1D anthropometric data. Key dimensions considered as constraints can supply the range of variation for each body area looked at, and other criteria are defined as a function of the fixed constraints. At the present time, work is done on the identification of the need of the consumer, analyzing shape variability. Analyzing the human body shape variability, using key sizing dimensions from each country must be paired with the analysis of the statistical methods used for the determining these key dimensions. Many different approaches for the comparison of the human body shape variability in each country will be evaluated as those proposed data by Lee 1999-2003. We have focused here our attention on some databases of countries such as Germany, France, Italy, Japan , US, Australia and Korea, an aimed at drawing a certain number of comparisons between the key dimensions of these, comparing them also with the body shape contents. The key dimensions concerned the chest [C], waist [W], height [He] and hips [H] and, in addition, the corresponding drop values C-W, C-H and W-H reviewed.

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Huaining Cheng and Kathleen Robinette

Air Force Research Lab, USA

Steve E. Mosher and Mark S. Boemer

General Dynamics Advanced Information Systems, USA

Development of the AFRL CAESAR Web User Interface

Abstract

Civilian American and European Surface Anthropometry Resource (CAESAR) (Robinette, et al., 2002) is an anthropometric database containing the latest civilian population survey of three countries representing the NATO countries: the United States of America, The Netherlands, and Italy. CAESAR contains over 4000 male and female survey subjects of different ethnic groups with ages ranging from 18 to 65. Data were collected for each individual subject for three postures. They consist of demographic, landmarks, traditional measurements, and 3-D laser full-body scans. There are many potential applications for the CAESAR database in the anthropometry, ergonomics, and biometrics fields because it provides individual and standardized one-mode data instead of summarized population information such as percentiles. Averages and percentiles are the wrong metrics to use for engineering. Robinette and McConville (1982) demonstrated that there is no such thing as a 5th percentile female or a 95th percentile male. In order for people to use the correct data in human modeling they need access to raw data and individual scans. However, people are not using CAESAR more frequently because it is too difficult to access at present. To facilitate the sharing of this valuable resource, the CARD Lab (Computerized Anthropometric Research and Design Laboratory) in the Air Force Research Laboratory has been developing a web application, ARIS (Anthropometry Research Information Systems), to offer CAESAR data search and analysis as well as raw data visualization and extraction. ARIS consists of two components. The front-end user interface was designed for two groups of potential users. An atlas-type graphics interface targets casual users, and a menu-driven detailed search interface satisfies the needs of advanced users. The back-end database was designed to handle not only the CAESAR database but also other anthropometric databases collected by the CARD Lab over the years. The objective is to provide a new capability to make the right anthropometric information available to anyone, anywhere.